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Developing and Evaluating an Educational Game to Support Early Reading Skills in Kindergarten Students

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Abstract
Reading is a crucial skill that should be learned from an early age, as it plays a vital role in daily life. While most children can easily learn to read, some struggle with the process. Therefore, effective learning media are needed to support children's reading development. This study develops and evaluates an educational game to assist young children in learning to read. Unlike previous studies, the game integrates multiple interactive modes that reinforce word recognition, spelling, and sentence construction through auditory and visual cues. The game features a simple user interface, a collection of 100 open vocabulary words, and three gameplay modes designed to support different aspects of early reading skills. The game's effectiveness was assessed through an experiment involving 12 kindergarten students, divided into a game-playing and a non-game-playing group. The findings indicate that the educational game can enhance kindergarten students' reading skills. Moreover, the game increases students' enthusiasm and motivation for learning to read. However, further improvements, such as additional features and platform expansion, are necessary to make the game more accessible to a broader audience.

Kata Kunci: *Educational Game, Early Reading Skills, Kindergarten Students.*

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Introduction

Reading is a fundamental skill that plays a crucial role in daily life. While many children acquire reading skills naturally, some struggle due to disparities in teaching quality, lack of parental support (Aini et al., 2023; Hasanah & Sugito, 2020), and genetic predispositions (Kovas et al., 2013). Additionally, the implementation of Indonesia's Ministry of National Education Regulation No. 70 on inclusive education (Menteri Pendidikan Nasional, 2009) presents challenges for regular schools in adapting facilities and teaching methods to accommodate diverse student needs. If these issues are not addressed appropriately, they may hinder children's cognitive and academic development.

Children with reading difficulties often exhibit delayed speech, poor verbal and spelling skills, and difficulty comprehending written text. Most reading disabilities are rooted in the deficiencies of phonemic awareness, decoding, and sight recognition of printed words (Scarborough et al., 2009). Addressing these difficulties requires targeted interventions to improve phonetic awareness, articulation, and memory for language sounds (Gillon et al.,

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2020). However, traditional teaching methods often fail to engage children with reading difficulties, resulting in reduced motivation and learning outcomes. This highlights the need for interactive and adaptive learning tools that cater to diverse student needs while maintaining engagement and effectiveness.

Educational games have emerged as a promising solution (Es-Sajjade & Paas, 2020), integrating learning content with interactive gameplay to enhance engagement and motivation (Hakim et al., 2023; Zeng et al., 2020). The concepts introduced in the game were designed to be simple and easily comprehensible (Bagus et al., 2021). Studies have shown that educational games can improve learning outcomes (Cheung & Ng, 2021), increase student participation (Yu et al., 2021), and reduce anxiety while fostering initiative (Chaidi & Drigas, 2022). Furthermore, educational games have been successfully utilized for children with learning difficulties, such as autism spectrum disorder (ASD), by reducing stress and increasing engagement (Sandra & Kurniawati, 2020). Teachers should efficiently use educational technology such as games by giving students the opportunity to make choices, which could boost students' confidence in their existing abilities (Osifo, 2019).

However, many existing educational games lack adaptability, intuitive design, and structured content tailored to early reading development. While previous research has explored game-based learning in literacy education, there remains a gap in developing structured, evidence-based educational games that systematically support early reading acquisition. Although research on game-based learning has expanded significantly since the late 1990s (Zeng et al., 2020), its application in structured early reading instruction remains limited. Some studies (Albion et al., 2021; Laine & Lindberg, 2020) have identified key motivators and design principles that enhance engagement, with (Albion et al., 2021) demonstrating that educational games can transform the learning environment by making lessons entertaining and compelling. Additionally, (Laine & Lindberg, 2020) identified 56 motivators and 54 design principles as guidelines for creating games that sustain player engagement. Despite these insights, their application in early reading instruction has yet to be fully explored.

To bridge this gap, this study aims to develop an educational game specifically designed to support early reading acquisition by incorporating research-backed principles of multimedia learning (Çeken & Taşkın, 2022), motivation-based game design (Laine & Lindberg, 2020), and text-to-speech technology (Dinçer, 2022). The game features an intuitive user interface, interactive elements, and a structured vocabulary system consisting of 100 open vocabulary words and basic sentence structures. By leveraging these features, the game offers a more engaging alternative to traditional reading instruction, supporting classroom and home-based learning. Furthermore, the design prioritizes accessibility and adaptability, ensuring it caters to diverse learning needs, including those of children with reading difficulties.

User experience (UX) and interface design play a critical role in the effectiveness of educational games. Research indicates well-designed user interfaces significantly impact engagement and learning efficiency (Jitnupong & Jirachiefpattana, 2018; Ruiz et al., 2021). Color psychology also influences user experience, as studies show that cool colors help maintain concentration while warm colors prevent fatigue (Lyu et al., 2022). Additionally, the choice of auditory elements, particularly text-to-speech technology, has enhanced comprehension and retention (Dinçer, 2022). By incorporating these design principles, the proposed educational game aims to create an optimal learning environment that encourages sustained engagement and effective reading development.

This research contributes to the field of educational technology by offering an evidence-based digital learning tool that addresses existing gaps in early reading instruction. The findings are expected to provide insights into optimizing educational game design for reading acquisition, inform future game-based learning research, and offer practical applications for educators and parents. By integrating structured vocabulary learning,

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motivational design elements, and adaptive gameplay mechanics, this study aims to bridge the divide between traditional reading instruction and modern interactive learning solutions, ultimately enhancing children's reading abilities and fostering a more inclusive learning environment.

Methodology

This study focuses on the development and evaluation of an educational game designed to support early reading acquisition in kindergarten-aged children. The methodology consists of two main parts: the design and implementation of the game and the evaluation of its effectiveness in enhancing children's reading abilities.

The educational game consists of three interactive game modes, each designed to facilitate different aspects of early reading skills. The game was developed with an emphasis on usability, engagement, and cognitive development. The first mode, Choose the Correct Word, presents an image of an object, either living or non-living, accompanied by an audio clip pronouncing its name. The player must select the correct word from multiple-choice options. A "Repeat Audio" button is available to replay the pronunciation for better auditory reinforcement. This mode helps children associate words with their meanings and improves word recognition through auditory and visual cues.

In the second mode, Arrange the Letters in Order, an image of an object appears on the screen along with scrambled letters. The player must drag and arrange the letters in the correct order to spell the word corresponding to the displayed image. To support learning, correctly placed letters remain fixed, while misplaced letters return to their original positions, allowing children to retry without frustration. This mode reinforces spelling skills and enhances word recognition through hands-on interaction.

The third mode, Complete the Sentence, presents an incomplete sentence with a missing word. The player selects the correct word or phrase from four given options to complete the sentence correctly. This mode is designed to help children practice constructing simple sentences used in daily communication. Immediate feedback is provided when a correct or incorrect answer is selected, reinforcing learning through guided correction.

The game's main menu provides easy navigation by listing all three game modes. A settings menu allows users to adjust sound preferences. The game adopts a crayon art style to create a visually engaging and child-friendly environment that appeals to young learners. Bright and high-saturation colors are used strategically to sustain children's attention while maintaining a balance between warm and cool tones for emotional stability.

The user interface (UI) design follows early childhood learning principles to ensure ease of use and engagement. The main screen is designed to be intuitive and uncluttered, allowing children to navigate easily. Each game mode is represented with illustrations to provide a clear understanding of the activities. Research-based color choices are implemented, where cool colors enhance concentration while warm colors prevent monotony. Interactive feedback mechanisms help guide the learning process—incorrect selections turn the button color to red for 0.5 seconds to provide immediate feedback, while correct answers turn the button to green before transitioning to the next question.

The participants in this study were selected based on specific criteria to ensure the research findings accurately reflect the impact of the educational game on early reading acquisition. The study involved children aged 5 to 6 years old, who were in the early stages of reading development. The selection process was conducted in collaboration with local elementary schools and kindergartens, ensuring a diverse participant pool in terms of learning abilities and socioeconomic backgrounds.

A subset of participants was identified based on teacher-reported early literacy challenges, such as difficulties in phonemic awareness and word decoding. This subset allowed for an evaluation of the game's effectiveness across a broader range of reading abilities.

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To assess the effectiveness of the educational game in improving children's reading skills, an experiment was conducted at St. Katarina Catholic Kindergarten involving 12 students from Kindergarten Class B. The students were divided into two equal groups of six participants each. The experimental group played the educational game before undergoing a reading assessment, while the control group did not play the game but took the same assessment.

Each student was given three oral reading questions covering word recognition, word spelling, and sentence completion. The experimental group engaged with the game before the assessment, whereas the control group proceeded directly to the test. Performance was evaluated by comparing the number of correct answers between the two groups. Since there were six students per group, a total of 18 questions (six students x three questions) were analyzed for each group. This structured approach ensures that the educational game's impact on reading skills can be effectively measured and compared.

Result and Discussion

The main screen of the game (Figure 1) is designed to be simple and colorful, making it easy for children to understand and navigate. Each game mode is represented with an illustration that gives an overview of its content. The player can select all modes from the beginning, allowing them to choose their preferred game mode.



Figure 1. Main menu screen



Figure 2. Category menu

The category menu (Figure 2) contains question categories for the "Choose the Correct Word" and "Arrange the Letters in Order" game modes. Each category is represented by an image corresponding to the type of questions in that mode, making it easier for children to identify and choose the appropriate game category.

The program (Figure 3) displays images along with corresponding answer choices. The voice instructions can be repeated by pressing a green button, allowing the player to hear the instructions again if needed. This feature aims to enhance user understanding through visuals and engagement with audio.



Figure 3. Example gameplay of "Choose the Correct Word"



Figure 4. Wrong button feedback

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When an incorrect answer is selected, the wrong choice turns red for 0.5 seconds (Figure 4), and the score for that question is set to 0. This immediate visual feedback helps children understand and learn from their mistakes.

When the correct answer is selected, it turns green for 0.5 seconds, followed by a pop-up (Figure 5) before moving on to the next question. This aims to provide immediate positive reinforcement, helping children recognize their success and encouraging continued engagement with the learning process.

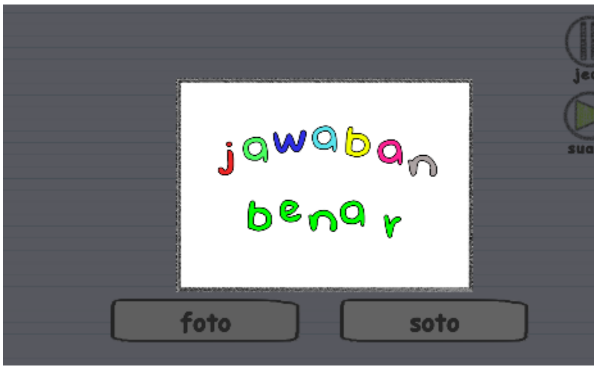


Figure 5. Positive feedback on the correct answer



Figure 6. Example gameplay of "Arrange the Letters in Order"

The program displays images and letters that must be dragged to the correct locations (Figure 6). The mechanics of this mode were adjusted to be compatible with mouse controls, enhancing interactivity. Nothing happens if a letter is placed in the wrong spot, providing a non-intrusive approach to learning.

In this game mode, the program displays an incomplete sentence, and the player must choose the correct option to complete it. This game mode aims to teach children how to form simple sentences that they can use in their daily lives. The available choices are clearly presented, and once the correct sentence is selected, the player moves on to the next question. (Figure 7). The feedback effects for correct or incorrect answers are the same as in the " Choose the Correct Word" game mode.



Figure 7. Example gameplay of "Complete the Sentence"

The testing results indicate that out of 18 questions administered to a group of six children, those who did not engage with the educational game answered only six questions correctly. In contrast, children who played the game successfully answered fifteen questions correctly (Figure 8). These findings suggest that the educational game may have a positive impact on children's reading abilities by enhancing their word recognition and comprehension skills.

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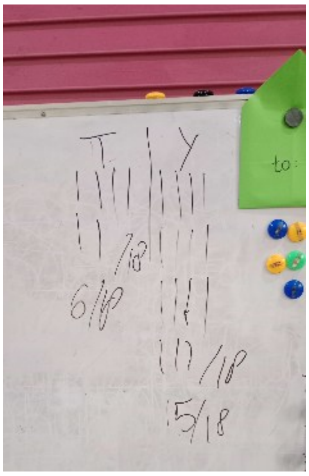


Figure 8. Comparative results of the two groups tested

From the observations, children's interest in learning to read increased after playing the educational game, as indicated by their desire to play the game multiple times, with none of the children getting bored. Additionally, the children participated in a vote to determine whether the game was fun or boring. All 6 children who played the game voted that it was fun (Figure 9). Furthermore, the children's enthusiasm was very high, as they began playing the game independently even before being instructed to do so again.



Figure 9. Comparison of game experience

Based on observations, interviews, and questionnaires given to the kindergarten B teachers, the educational game can be applied to improve classroom effectiveness. According to the interviews with the teachers, the game can be used for children who are struggling or falling behind in learning to read in the classroom. Additionally, the game can be played by children at home, allowing them to continue learning outside of school. However, the game platform must be adapted into a mobile game, as not all children can access computers and laptops. The educational game helps children recognize vowels and consonants, but it is unsuitable for children who cannot read, making it more appropriate for kindergarten B students. Furthermore, the results of the questionnaire from the teacher show that the respondents agreed that the game helps improve children's reading abilities and increases their interest in learning.

These findings align with previous studies that emphasize the role of educational games in enhancing early literacy skills. Research suggests that interactive digital media can provide a more engaging learning environment compared to traditional teaching methods, leading to better retention and motivation among young learners (Ronimus et al., 2019). Similarly, gamification in early reading education has been shown to significantly improve

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phonemic awareness and word recognition, particularly for children who struggle with conventional learning approaches (Ungau et al., 2023).

The positive impact of the educational game in this study is also supported by Cognitive Load Theory (Sweller, 1988), which suggests that well-designed interactive media can reduce cognitive overload by breaking down learning tasks into manageable segments (Sweller et al., 2011). The structure of this game, which provides immediate feedback and scaffolding mechanisms, ensures that children receive gradual guidance while acquiring new reading skills. This is consistent with findings that indicate step-by-step reinforcement in gamified learning facilitates knowledge acquisition and minimizes frustration in early readers (de Jong, 2010).

Multisensory learning—incorporating visual, auditory, and kinesthetic elements—plays a crucial role in early literacy development. Research indicates that children learn words more effectively when they associate spoken names with corresponding visual or tactile experiences (Mason et al., 2019). Similarly, integrating speech and text in educational games has been shown to enhance phonemic awareness and cognitive skills (Hadders-Algra, 2020).

However, while the results demonstrate promising outcomes, it is essential to consider potential limitations in accessibility and inclusivity. Digital learning tools may pose challenges for children from lower socioeconomic backgrounds, particularly those with limited access to the internet, shared household devices, or parents with low digital literacy (Qaribilla et al., 2024; Zhao, 2023). To further enhance accessibility, future iterations of the game could incorporate adaptive difficulty levels and voice recognition technology to accommodate children with varying literacy skills.

Furthermore, the role of parental involvement in digital learning is another crucial factor to consider. Young children benefit significantly when parents actively engage in their educational gaming experiences, providing guidance and reinforcement (Amelia et al., 2023; Jeynes, 2012). Future research could explore how integrating parental feedback mechanisms into the game may further enhance learning outcomes.

Overall, the findings from this study contribute to the growing body of literature on educational game in early childhood education. The results reinforce previous studies that highlight the effectiveness of educational learning (Candra et al., 2024) environments in fostering early reading skills (Khadijah et al., 2022). However, further studies with larger sample sizes and long-term assessments are necessary to fully understand the game's impact on literacy development over time.

Conclusion

This study concludes that educational games can serve as an effective supplementary tool for enhancing early literacy skills among kindergarten B students, particularly those struggling with reading. Based on testing results, interviews, questionnaires, and analysis, the interactive and engaging nature of the educational game has demonstrated its ability to increase children's enthusiasm and motivation to learn. The game effectively aids in vowel and consonant recognition, with experimental results indicating that children who engaged with the educational game performed better in reading tasks compared to those who did not. These findings align with previous research emphasizing the role of gamification in early childhood education, reinforcing the potential of digital learning tools to support foundational literacy development.

Furthermore, this study contributes to the growing body of literature on the integration of digital learning tools in classroom settings. By leveraging interactive media and immediate feedback mechanisms, the game provides structured support that aligns with Cognitive Load Theory, ensuring that children can gradually develop their reading skills without experiencing cognitive overload. The inclusion of multisensory learning elements further enhances phonemic awareness and knowledge retention, supporting established research on effective early literacy interventions.

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However, this study has certain limitations. The research was conducted with a relatively small sample size, which may limit the generalizability of the findings. Additionally, the study primarily focused on short-term learning outcomes, whereas long-term literacy retention and development were not assessed. The reliance on teacher and student feedback, while valuable, may also introduce subjective biases. Furthermore, accessibility concerns remain a key issue, as not all children have access to laptops or PCs, making it essential to explore more inclusive platforms.

For future research, it is recommended that the educational game be further developed into a mobile or tablet-based application to increase accessibility for children at home. Additionally, incorporating a teacher-controlled lock game mode could enhance structured learning, allowing students to focus on specific literacy skills at a time. Expanding the study to include more schools from diverse socioeconomic backgrounds will be essential to ensure broader applicability of the findings. Moreover, future iterations of the game could integrate adaptive difficulty levels and voice recognition technology to accommodate children with varying literacy skills. By addressing these areas, future studies can build upon the findings of this research to further enhance the role of educational games in improving early literacy education.

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